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Editors: Gary Presland, Maria Gibson, Sue Forster

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Front cover: Rainbow Lorikeet *Trichoglossus haematodus*. Photo Virgil Hubregtse. See p. 181.

Back cover: Little Corellas *Cacatua sanguinea* on a cypress tree. Photo Virgil Hubregtse. See p. 181.

Survey of the bird fauna of Benarca Forest near Echuca–Moama on the Murray River, New South Wales

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Abstract

A survey of a small (206 ha) riverine woodland remnant on the Murray River recorded 97 bird species (23 waterbirds and 74 woodland birds) including residents, spring/summer latitudinal migrants and winter altitudinal migrants. The conservation values of this remnant include habitat value for 15 declining woodland bird species and three waterbird species of conservation concern, as well as landscape connectivity value as part of a major riverine wildlife corridor. Several declining woodland bird species exhibited local preferences for particular vegetation communities. (*The Victorian Naturalist* 138(6), 2021, 160–170)

Keywords: Declining woodland birds, remnant woodland, Riverina bioregion, waterbirds, wildlife corridor

Introduction

The riverine forests and woodlands of the Murray River on the New South Wales (NSW)/Victoria border provide significant habitat for wetland and woodland birds and now comprise some of the largest and best-connected remnant woodland areas in the agriculture-dominated landscape of the Murray–Darling Basin (Kingsford *et al.* 2014). The two largest areas of River Red Gum *Eucalyptus camaldulensis* Forest in the Murray–Darling Basin are the 70 000 ha Barmah–Millewa Forest and 50 000 ha Gunbower–Koondrook–Perricoota Forest near Echuca–Moama (Murray–Darling Basin Commission 2006; Dutson *et al.* 2009; Hale and Butcher 2011a, 2011b; Harrington and Hale 2011). Published avifauna studies based in these two large forest blocks include Leslie (2001), Mac Nally *et al.* (2001), Loyn *et al.* (2002), Antos and Bennett (2005), Webster and Rogers (2006), Mac Nally and Horrocks (2007) and Selwood *et al.* (2015). There is also a considerable quantity of unpublished research (e.g. Webster 2017; Robinson 2018; Borrell and Belcher 2020; Webster and Borrell 2020).

Comparatively little is known about the avian values of the 70 km long riverine forest corridor that links the Barmah–Millewa Forest and Gunbower–Koondrook–Perricoota Forest. The aim of the present study is to describe the bird assemblage of Benarca Forest, a small forested area located along this corridor, and highlight species of identified conservation concern.

NSW declining woodland birds are defined in this paper as any woodland bird species listed on schedules 1 or 3 of the NSW *Biodiversity Conservation Act 2016*, listed as a decliner by Reid (1999), or listed as endangered, vulnerable or near threatened by Traill and Duncan (2000). The paper also highlights wetland and woodland species of conservation concern in Victoria (Victorian Department of Sustainability and Environment (DSE) 2013; Victorian Department of Environment, Land, Water and Planning (DELWP) 2021).

Methods

Study area

Benarca Forest (36° 3.7' S, 144° 36.9' E) (Fig. 1) is located in Yorta Yorta Aboriginal Country in the Riverina bioregion in southern inland NSW. It is 206 ha in area and is situated on the north bank of the Murray River, 13 km north-west of Echuca–Moama. Located within a southward loop of the river, it is surrounded on three sides (east, south and west) by Victoria. The forest was managed for commercial timber production over the period 1920–2010, with harvesting for construction timber, fence posts and railway sleepers. The last harvesting operation took place in 1991. Benarca Forest was gazetted as part of Murray Valley Regional Park in 2010 and is now managed by the NSW National Parks and Wildlife Service for recreation and conservation.

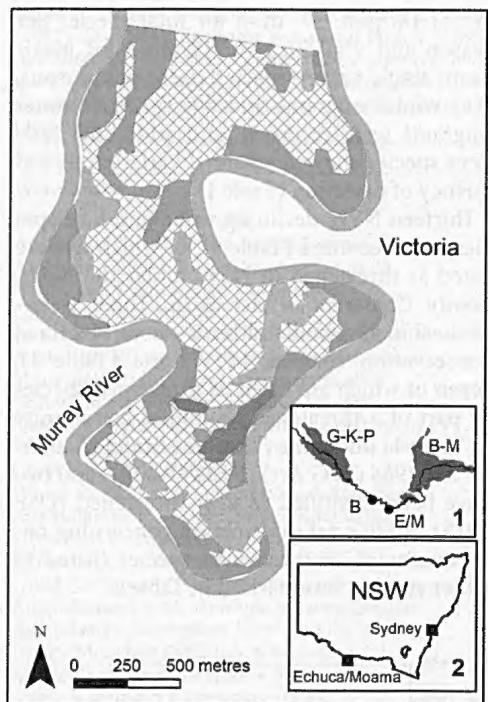


Fig. 1. Map of Benarca Forest study area. Vegetation: solid pink = River Red Gum forest, solid grey = Inland Grey Box woodland, pink cross-hatching = mixed box/gum woodland, solid yellow = sandhill pine woodland. Vegetation mapping produced by the author. Inset map 1 shows the location of Benarca Forest (B) in relation to the Barmah-Millewa (B-M) and Gunbower-Koondrook-Perricoota (G-K-P) Forests and Echuca-Moama (E/M). The black line shows the Murray River. Inset map 2 shows the location in NSW.

The climate is temperate, with a winter-dominant rainfall pattern and an annual rainfall of about 425 mm (Bureau of Meteorology data). The dominant vegetation comprises River Red Gum Forest (53 ha) in low-lying areas subject to flooding, and Inland Grey Box *Eucalyptus microcarpa* Woodland (27 ha) on slightly higher ground. These two communities intergrade extensively, forming a Mixed Box-Gum Woodland (121 ha) which also includes a small number of Black Box *Eucalyptus largiflorens*. The understorey is predominantly grasses and forbs with scattered stands of Silver Wattle *Acacia dealbata*, Pale-fruit Ballart *Exocarpos strictus* and Buloke *Allocasuarina luehmannii*. Small areas of sandhill support White Cypress Pine

Callitris glauophylla Sandhill Pine Woodland (5 ha). The 8.7 km length of adjacent river was included in the study area, comprising open water and small stands of fringing reeds.

Survey methods

A series of 100 random walk diurnal surveys for birds, following Fjeldså (1999), Kessler *et al.* (2001) and Murphy (2020), was done in Benarca Forest over the period February 2019 to April 2021. This involved walking slowly and quietly through the study area, listing all species seen or heard within about 50 m of the observer. The duration of each survey was about three hours. There were 25 surveys per season and no more than 10 surveys in any month. Surveys were not held on days when heavy rain or strong winds prevailed. From April 2020 individual sightings of NSW declining woodland bird species were mapped with a hand-held GPS device in order to investigate any spatial distribution patterns. Nocturnal surveys were done on four nights (two in spring, one in summer and one in autumn), looking and listening for nocturnal birds while walking with a hand-held torch or slowly driving along park roads. The duration of each nocturnal survey was about one hour.

Data analysis

All species recorded in the diurnal surveys were assigned to one of four categories of frequency of detection: rare (recorded in 1–4 surveys), uncommon (5–25 surveys), common (26–75) and abundant (76–100). For known seasonal migrants these categories were scaled to the number of seasons when they were recorded. Species only recorded opportunistically outside the survey period were also assigned to the rare category. Information on frequency of detection was collated and used to produce a frequency histogram. A species accumulation curve was also generated using data pooled in ten-survey increments in order to examine the likely survey completeness.

Broad seasonal patterns were investigated by comparing the total number of species recorded in each season, and the maximum number of species recorded in a single survey for each season, using 2×4 chi-squared goodness of fit tests (testing against expected equality).

NSW declining woodland bird species with 10 or more spatial records had all locations mapped in GIS and their distribution compared with a vegetation map for Benarca Forest produced by the author.

Results

Ninety-six bird species (22 waterbirds and 74 woodland birds) were recorded in the systematic diurnal surveys (Table 1), including three nocturnal species. Two of these nocturnal species (Southern Boobook *Ninox boobook* and Australian Owlet-nightjar *Aegotheles cristatus*) were also recorded during night spotlight surveys. One additional waterbird species (Australasian Grebe *Tachybaptus novaehollandiae*) was recorded incidentally after the conclusion of the systematic survey (in June 2021). A histogram summarising frequency of occurrence from the diurnal survey data is provided as Fig. 2. Species in the common to abundant categories comprised 47% of the total. Five species were recorded in 95% or more of surveys: Galah *Eolophus roseicapilla*, Sulphur-crested Cockatoo *Cacatua galerita*, Brown Treecreeper *Climacteris picumnus*, White-plumed Honey-eater *Ptilotula penicillata* and Australian Magpie *Cracticus tibicen*. Eight species were only represented by single records in the diurnal surveys and this, together with the shape of the species accumulation curve (Fig. 3), suggests further survey effort would have probably identified additional species—a point borne out by the addition of Australasian Grebe.

The lowest species diversity occurred in winter and the highest in spring (Fig. 4) but these differences were not statistically significant

($\chi^2 = 1.18$, $p=0.757$, $df=3$ for total species per season and $\chi^2 = 0.50$, $p=0.919$, $df=3$ for maximum single survey species count per season). Five winter migrants and five spring/summer migrants were recorded, and additional resident species showed seasonal variation in frequency of detection (Table 1).

Thirteen NSW declining woodland bird species were recorded (Table 1), of which five are listed as threatened in NSW under the *Biodiversity Conservation Act 2016*. Three waterbirds and six woodland birds are of identified conservation concern in Victoria (Table 1), seven of which are listed as threatened species or part of a threatened ecological community in Victoria under the *Flora and Fauna Guarantee Act 1988* (FFG Act) (DELWP 2021) and two have been identified as near-threatened (DSE 2013). Additional information concerning observations of 10 threatened species (listed in either state) is summarised in Table 2.

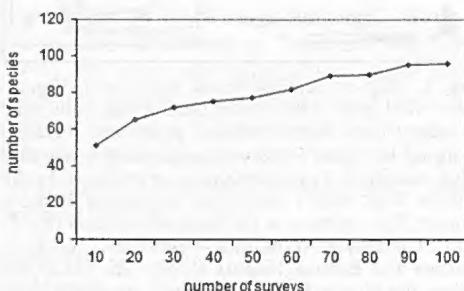


Fig. 3. Species accumulation curve for Benarca Forest bird survey.

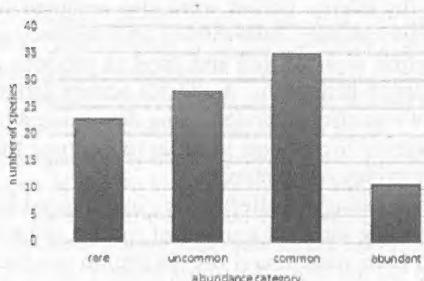


Fig. 2. Frequency histogram for Benarca Forest bird survey.

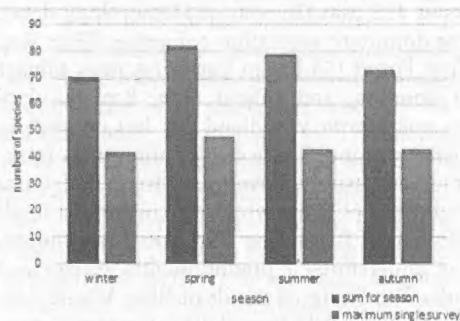


Fig. 4. Number of bird species recorded per season in Benarca Forest.

Table 1. Birds of Benarca Forest 2019–2021. Nomenclature and taxonomic order based on Menkhorst *et al.* (2017). D = NSW declining woodland bird. T = listed as threatened in NSW under *Biodiversity Conservation Act 2016*. V = species of conservation concern in Victoria (DSE 2013; DELWP 2021). Status (based on frequency of detection): R = rare, U = uncommon, C = common, A = abundant, * = incidental record. Seasonally adjusted values shown in brackets. Seasonal pattern shown for all species in uncommon, common or abundant categories.

Species	Status	Seasonal pattern
Waterbirds		
Black Swan <i>Cygnus atratus</i>	R	-
Australian Shelduck <i>Tadorna tadornoides</i>	U	Migrant winter/early spring
Australian Wood Duck <i>Chenonetta jubata</i>	A	Resident
Pacific Black Duck <i>Anas superciliosa</i>	C	Resident
Grey Teal <i>Anas gracilis</i>	U	Resident
Australasian Grebe <i>Tachybaptus novaehollandiae</i>	R*	-
Australian White Ibis <i>Threskiornis molucca</i>	R	-
Straw-necked Ibis <i>Threskiornis spinicollis</i>	U	Resident
Yellow-billed Spoonbill <i>Platalea flavipes</i>	U	Resident
Nankeen Night-Heron <i>Nycticorax caledonicus</i> (V)	R	-
White-necked Heron <i>Ardea pacifica</i>	R	-
Great Egret <i>Ardea alba</i> (V)	R	-
White-faced Heron <i>Egretta novaehollandiae</i>	U	Resident
Australian Pelican <i>Pelecanus conspicillatus</i>	U	Resident
Little Pied Cormorant <i>Microcarbo melanoleucos</i>	C	Resident
Little Black Cormorant <i>Phalacrocorax sulcirostris</i>	U	Resident
Great Cormorant <i>Phalacrocorax carbo</i>	R	-
Australasian Darter <i>Anhinga novaehollandiae</i>	C	Resident most common winter
Australasian Swamphen <i>Porphyrio melanotus</i>	C	Resident
Dusky Moorhen <i>Gallinula tenebrosa</i>	U	Resident
Masked Lapwing <i>Vanellus miles</i>	R	-
Azure Kingfisher <i>Ceyx azureus</i> (V)	U	Resident
Australian Reed-Warbler <i>Acrocephalus australis</i>	U	Migrant spring
Woodland birds		
Little Eagle <i>Hieraetus morphnoides</i> (D) (T) (V)	U	Resident
Wedge-tailed Eagle <i>Aquila audax</i>	U	Resident
Collared Sparrowhawk <i>Accipiter cirrocephalus</i>	R	-
Whistling Kite <i>Haliastur sphenurus</i>	C	Resident
Common Bronzewing <i>Phaps chalcoptera</i>	C	Resident most common spring/summer
Crested Pigeon <i>Ocyphaps lophotes</i>	R	-
Peaceful Dove <i>Geopelia placida</i> (D)	C	Resident most common spring/summer
Fan-tailed Cuckoo <i>Cacomantis flabelliformis</i>	U	Migrant late winter/early spring
Southern Boobook <i>Ninox boobook</i>	R	-
Tawny Frogmouth <i>Podargus strigoides</i>	U	Resident
Australian Owlet-nightjar <i>Aegotheles cristatus</i>	R	-
Dollarbird <i>Eurystomus orientalis</i>	(C)	Migrant late spring/summer
Laughing Kookaburra <i>Dacelo novaeguineae</i>	A	Resident
Sacred Kingfisher <i>Todiramphus sanctus</i>	C	Migrant spring/summer
Rainbow Bee-eater <i>Merops ornatus</i>	C	Migrant spring/early autumn
Nankeen Kestrel <i>Falco cenchroides</i>	R	-
Peregrine Falcon <i>Falco peregrinus</i>	R	-
Galah <i>Eolophus roseicapilla</i>	A	Resident
Long-billed Corella <i>Cacatua tenuirostris</i>	C	Resident
Little Corella <i>Cacatua sanguinea</i>	U	Resident
Sulphur-crested Cockatoo <i>Cacatua galerita</i>	A	Resident
Yellow Rosella <i>Platycercus elegans flaveolus</i>	C	Resident
Eastern Rosella <i>Platycercus eximius</i>	C	Resident
Red-rumped Parrot <i>Psephotus haematonotus</i>	C	Resident most common spring/summer
White-throated Treecreeper <i>Cormobates leucophaea</i>	C	Resident
Brown Treecreeper <i>Climacteris picumnus</i> (D)	A	Resident
Superb Fairy-wren <i>Malurus cyaneus</i>	C	Resident
Little Friarbird <i>Philemon citreogularis</i>	C	Resident most common spring/summer
Noisy Friarbird <i>Philemon corniculatus</i>	C	Resident least common winter

Table 1. cont.

Species	Status	Seasonal pattern
Blue-faced Honeyeater <i>Entomyzon cyanotis</i>	U	Resident
Brown-headed Honeyeater <i>Melithreptus brevirostris</i> (V)	U	Resident
Red Wattlebird <i>Anthochaera carunculata</i>	C	Resident most common autumn/winter
Noisy Miner <i>Manorina melanocephala</i>	R	-
White-plumed Honeyeater <i>Ptilotula penicillata</i>	A	Resident
Spotted Pardalote <i>Pardalotus punctatus</i>	C	Resident least common summer
Striated Pardalote <i>Pardalotus striatus</i>	A	Resident least common summer
White-browed Scrubwren <i>Sericornis frontalis</i>	U	Resident
Weebill <i>Smicrornis brevirostris</i>	U	Resident
Western Gerygone <i>Gerygone fusca</i> (V)	C	Resident
Buff-rumped Thornbill <i>Acanthiza reguloides</i>	C	Resident
Yellow-rumped Thornbill <i>Acanthiza chrysorrhoa</i>	C	Resident
Yellow Thornbill <i>Acanthiza nana</i>	U	Resident
Striated Thornbill <i>Acanthiza lineata</i>	R	-
White-browed Babbler <i>Pomatostomus superciliosus</i> (D)	C	Resident
White-breasted Woodswallow <i>Artamus leucorynchus</i>	R	-
Dusky Woodswallow <i>Artamus cyanopterus</i> (D) (T)	U	Resident
Pied Butcherbird <i>Cracticus nigrogularis</i>	U	Resident
Australian Magpie <i>Cracticus tibicen</i>	A	Resident
Pied Currawong <i>Strepera graculina</i>	(C)	Migrant late autumn/early spring
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>	C	Resident least common winter
White-winged Triller <i>Lalage tricolor</i>	R	-
Varied Sittella <i>Daphoenositta chrysopetra</i> (D) (T)	U	Resident
Crested Shrike-tit <i>Falcunculus frontatus</i> (D)	U	Resident
Golden Whistler <i>Pachycephala pectoralis</i>	U	Migrant late autumn/early spring
Rufous Whistler <i>Pachycephala rufiventris</i> (D)	C	Resident most common spring/summer
Grey Shrike-thrush <i>Colluricinclla harmonica</i>	A	Resident
Olive-backed Oriole <i>Oriolus sagittatus</i>	R	-
Willie Wagtail <i>Rhipidura leucophrys</i>	A	Resident
Grey Fantail <i>Rhipidura albiscapa</i>	C	Resident most common autumn/winter
Magpie-lark <i>Grallina cyanoleuca</i>	C	Resident least common winter
Restless Flycatcher <i>Myiagra inquieta</i> (D)	U	Resident
Little Raven <i>Corvus mellori</i>	C	Resident
Australian Raven <i>Corvus coronoides</i>	C	Resident
White-winged Chough <i>Corcorax melanorhamphos</i>	A	Resident
Jacky Winter <i>Microeca fascinans</i> (D) (V)	C	Resident
Flame Robin <i>Petroica phoenicea</i> (D) (T)	(C)	Migrant late autumn/winter
Red-capped Robin <i>Petroica goodenovii</i> (D) (V)	R	-
White-backed Swallow <i>Cheramoeca leucosterna</i>	U	Resident least common winter
Welcome Swallow <i>Hirundo neoxena</i>	C	Resident
Fairy Martin <i>Petrochelidon ariel</i>	(C)	Migrant spring/summer
Tree Martin <i>Petrochelidon nigricans</i>	R	-
Silvereye <i>Zosterops lateralis</i>	R	-
Diamond Firetail <i>Stagonopleura guttata</i> (D) (T) (V)	R	Resident
Red-browed Finch <i>Neochmia temporalis</i>	R	-

Collection of individual spatial records of the 13 NSW declining woodland birds provided a combined dataset of 634 records (of which 45% were Brown Treecreeper). Eleven species had sufficient records for examination of spatial distributions in GIS and four apparent distribution patterns were identified (Fig. 5):

1. Widely distributed in the forest with no identified preference for particular vegetation communities: Peaceful Dove *Geopelia placida*, Brown Treecreeper and Restless Flycatcher *Myiagra inquieta*.

2. Preference for Box Woodland and Mixed Box-Gum Woodland: Dusky Woodswallow *Artamus cyanopterus* and Crested Shrike-tit *Falcunculus frontatus*.
3. Preference for Mixed Box-Gum Woodland and River Red Gum Forest in the northern half of the forest: Varied Sittella *Daphoenositta chrysopetra*, Rufous Whistler

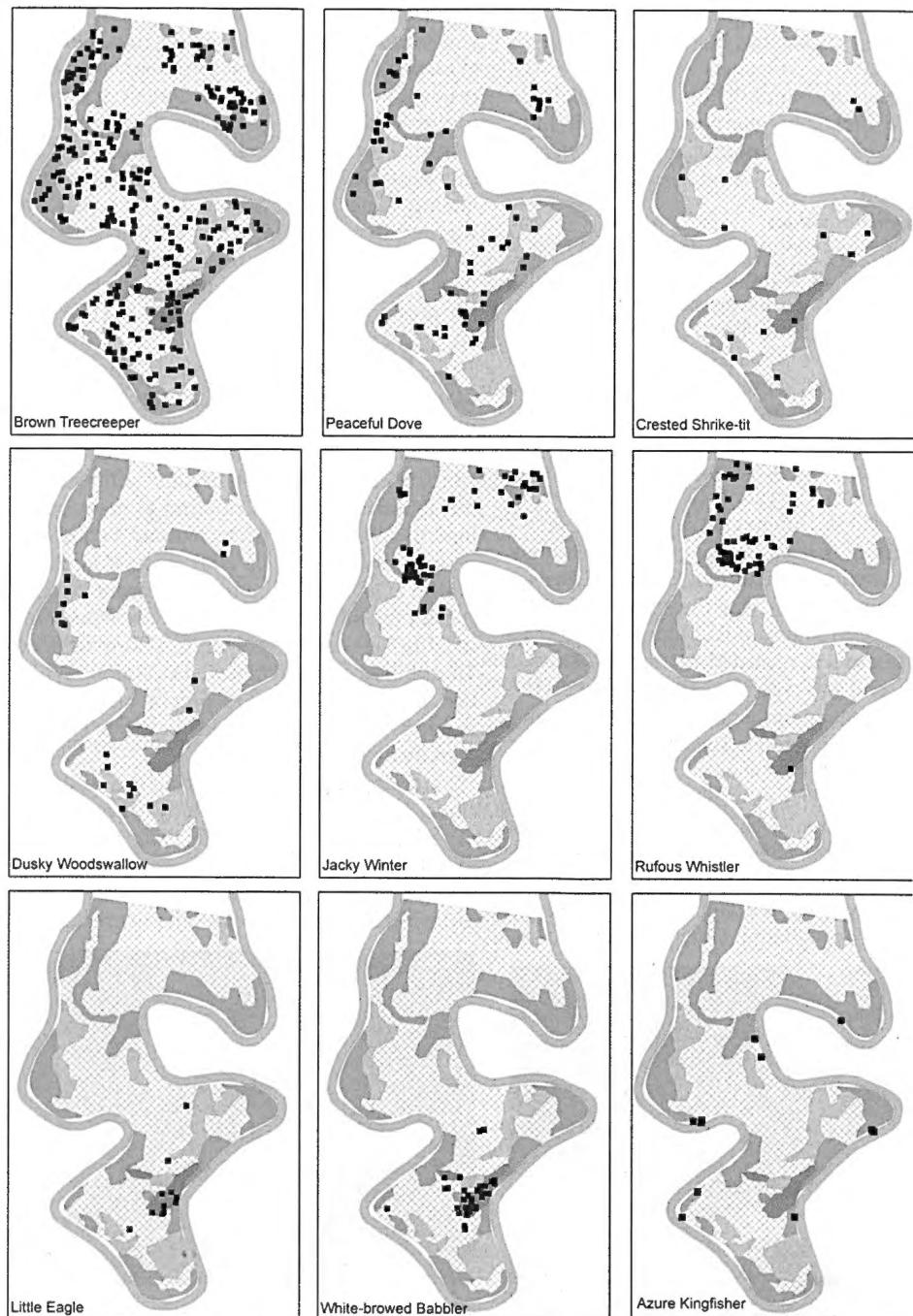


Fig. 5. Distribution of records of nine species in Benarca Forest bird survey. Map background colour coding as per Fig. 1.

Pachycephala rufiventris, Jacky Winter *Microeca fascinans* and Flame Robin *Petroica phoenicea*.

4. Preference for Sandhill Pine Woodland: Little Eagle *Hieraetus morphnoides* and White-browed Babbler *Pomatostomus superciliosus*.

Discussion

Conservation values

This study has identified some of the conservation values of Benarca Forest. Avian values include 13 NSW declining woodland birds, five of which are currently listed as threatened species in NSW. Five of the 24 species defining the threatened Victorian temperate woodland bird community listed under the FFG Act (DELWP 2021) were recorded, including two that are additional to the list of NSW declining woodland birds: Western Gerygone *Gerygone fusca* and Brown-headed Honeyeater *Melithreptus brevirostris*. All 15 species are becoming increasingly rare in the wider agricultural landscape. Brown Treecreeper (Fig. 6) was the most frequently recorded declining woodland bird, widespread in the forest and recorded in 100% of diurnal surveys, and was typically seen foraging on the ground, on fallen timber and on the trunks and larger branches of trees. The local population is considered likely to belong to the inland subspecies *Climacteris picumnus picumnus* rather than the threatened eastern *C. picumnus victoriae*, with the narrow intergradation zone between the two located along the mid-outer western slopes of the Great Dividing Range near Maryborough and Albury-Corowa to the



Fig. 6. Brown Treecreeper *Climacteris picumnus* in Benarca Forest. This species forages extensively on fallen timber.

south and east of Echuca-Moama (Schodde and Mason 1999; Higgins *et al.* 2001). Rufous Whistler (Fig. 7) was a commonly recorded resident with a distribution largely restricted to the northern part of the forest, where it was recorded foraging or calling in the canopy. Although found in all months, it was more frequently detected in spring/summer (62% of surveys) than autumn/winter (26% of surveys). Other commonly recorded residents included Peaceful Dove (50% of surveys), Jacky Winter (49%), White-browed Babbler (41%) and Western Gerygone (38%).

The hyper-aggressive colonial Noisy Miner *Manorina melanocephala* was rarely recorded in Benarca Forest, detected on only a single occasion during this study. The presence of Noisy Miner has a strong negative influence on the abundance and distribution of many small insectivorous and nectarivorous woodland passerines (Major *et al.* 2001; Eyre *et al.* 2009; Maron *et al.* 2013). The frequent occurrence of species including Striated Pardalote *Pardalotus striatus*, Western Gerygone, Yellow-rumped Thornbill *Acanthiza chrysorrhoa*, Rufous Whistler and Grey Fantail *Rhipidura albiscapa* in Benarca Forest may, in part, be related to the scarcity of Miners there.

Waterbird values noted during the study include a small breeding colony (three nests) of Yellow-billed Spoonbill *Platalea flavipes* in the canopy of River Red Gums, and three waterbirds of conservation concern in Victoria: Great Egret *Ardea alba* (threatened),



Fig. 7. Rufous Whistler *Pachycephala rufiventris* (male) in Benarca Forest. This species was present all year but was most readily detected by its song during the breeding season.

Table 2. Summary of NSW/Victorian threatened species records from 2019–2021 survey of Benarca Forest
 NSW status (*Biodiversity Conservation Act 2016*) and Vic status (*Flora and Fauna Guarantee Act 1988*): V = vulnerable, WBC = part of threatened Victorian temperate woodland bird community.

Name	NSW status	VIC status	Notes
Great Egret <i>Ardea alba</i>	-	V	Rare summer visitor, recorded in 2% of diurnal surveys. Single birds foraging on riverside in February 2019 and February 2020.
Little Eagle <i>Hieraetus morphnoides</i>	V	V	Uncommon resident, recorded in 11% of diurnal surveys with records in all seasons. Most records of single birds flying high or low over canopy, one record of two birds perched in tree (September). Majority of records in or near sandhill pine woodland. Likely nesting in vicinity.
Brown-headed Honeyeater <i>Melithreptus brevirostris</i>	-	WBC	Uncommon resident, recorded in 15% of diurnal surveys. Recorded in all seasons, more frequently in autumn–winter (10%) than spring–summer (5%). Generally seen in groups of up to six birds foraging in canopy of Mixed Box–Gum Woodland in north of forest.
Western Gerygone <i>Gerygone fusca</i>	-	WBC	Common resident, recorded in 38% of diurnal surveys with records in all seasons. Generally recorded singly, foraging or calling in canopy of Mixed Box–Gum Woodland in north of forest.
Dusky Woodswallow <i>Artamus cyanopterus</i>	V	-	Uncommon resident of Box Woodland and Mixed Box–Gum Woodland. Recorded in 20% of diurnal surveys with records in all seasons. Single birds or groups of up to five birds. Juvenile birds seen in February.
Varied Sittella <i>Daphoenositta chrysopera</i>	V	-	Uncommon resident, recorded in 13% of diurnal surveys with records in all seasons. Found in Red Gum Forest and Mixed Box–Gum Woodland in north of forest. Single birds or small groups of up to 4 birds foraging on box and red gum trees, including standing dead trees.
Jacky Winter <i>Microeca fascinans</i>	-	WBC	Common resident, recorded in 49% of diurnal surveys with records in all seasons. Generally seen singly or in pairs, either sally-foraging within 2m of the ground or calling from high in canopy. Preference for Mixed Box–Gum Woodland and Red Gum Forest in the north of forest.
Flame Robin <i>Petroica phoenicea</i>	V	-	Common autumn–winter migrant, recorded in 23% of diurnal surveys (7% in autumn and 16% in winter) with records early May–late August. Single birds or loose groups of up to 6 birds generally seen on ground or perched on fallen timber and stumps in Mixed Box–Gum Woodland and Red Gum Forest in north of forest.
Red-capped Robin <i>Petroica goodenovii</i>	-	WBC	Rare autumn visitor, recorded in 4% of diurnal surveys with records in late April and May. Single birds generally seen on ground or perched on fallen timber and low branches in Red Gum Forest and Mixed Box–Gum Woodland in north of forest.
Diamond Firetail <i>Stagonopleura guttata</i>	V	V, WBC	Rare resident of Mixed Box–Gum Woodland in north of forest, recorded in 3% of diurnal surveys with records in October, December and January. Three records of single birds and 1 record of 4 birds. Generally seen on ground.

Nankeen Night-Heron *Nycticorax caledonicus* (near-threatened) and Azure Kingfisher *Ceyx azureus* (near-threatened) (DSE 2013; DELWP 2021). Great Egret and Nankeen Night-Heron were both rarely recorded (2% and 1% of diurnal surveys respectively). Azure Kingfisher was recorded in 8% of surveys, with records distributed along the riverside (Fig. 5) and occurring in all seasons, including a pair attending a burrow high in the riverbank in October.

Benarca Forest also supports other significant fauna species including the Inland Carpet Python *Morelia spilota metcalfei* (pers. obs. October 2020 and June 2021). This subspecies is of conservation concern in both NSW (Shine 1994; Michael and Lindenmayer 2008) and Victoria (DSE 2013; DELWP 2021). Two of the vegetation communities found in Benarca Forest, Inland Grey Box Grassy Woodland and Sandhill Pine Woodland, are covered by endangered ecological community listings in NSW under the *Biodiversity Conservation Act 2016*.

Temporal and spatial distribution patterns

Seasonal variations in the bird community of Benarca Forest include spring/summer-visiting latitudinal migrants such as Dollarbird *Eurystomus orientalis*, Sacred Kingfisher *Todiramphus sanctus* and Rainbow Bee-eater *Merops ornatus*, and winter-visiting altitudinal migrants such as Pied Currawong *Strepera graculina*, Golden Whistler *Pachycephala pectoralis* and the threatened Flame Robin. Several resident species also vary seasonally in frequency of detection, either due to the likely seasonal influx of additional individuals (such as Little Friarbird *Philemon citreogularis*) or increased detectability during the breeding season (such as Peaceful Dove and Rufous Whistler).

Differences in type of woodland vegetation can have a profound influence on bird community composition (Major *et al.* 2001; Antos and Bennett 2005; Murphy 2012). Apparent preferences for particular vegetation communities were identified in eight of the 13 NSW declining woodland bird species in the present study. For example, over 90% of White-browed Babbler records were in or near Sandhill Pine Woodland (which comprised only 2% of the area of Benarca Forest), while over 85% of Dusky Woodswallow records were in or

near Inland Grey Box Woodland (13% of the Forest). Both species are known to occupy a wider range of woodland types, with White-browed Babbler recorded from Grey Box Woodland and River Red Gum Forest (Higgins and Peter 2002) and Dusky Woodswallow recorded from River Red-Gum Forest (Higgins *et al.* 2006). The association of White-browed Babbler with Cypress Woodland described here is consistent with previous reports in the local area (Hobbs 1961; Webster and Rogers 2006). The apparent preferences of other species in Benarca Forest are considered likely to be site-specific phenomena reflecting the complexity of species' finer scale distributions.

Comparison with nearby larger forest areas

The 23 waterbird species recorded in Benarca Forest represent about 35% of the waterbird assemblage known from the Barmah–Millewa and Gunbower–Koondrook–Perricoota Forests combined, while the 74 woodland birds represent about 53% of the native woodland bird assemblage (Leslie 2001; Mac Nally *et al.* 2001; Loyn *et al.* 2002; Antos and Bennett 2005; Webster and Rogers 2006; Selwood *et al.* 2015; Webster 2017; Robinson 2018; Webster and Borrell 2020). This reflects the shorter survey period, smaller size of the study area and more limited range of habitats present. Additional valuable bird habitats found in these larger forest blocks include lakes, billabongs, wetland reedbeds, Black Box Woodland and Yellow Box *Eucalyptus melliodora* Woodland.

Many of the species frequently recorded in the present study also have high reporting rates in the larger forest blocks, including Galah, Sulphur-crested Cockatoo, Brown Treecreeper, White-plumed Honeyeater and Striated Pardalote (Mac Nally *et al.* 2001; Loyn *et al.* 2002; Antos and Bennett 2005; Webster and Rogers 2006; Selwood *et al.* 2015). Interestingly, there were also a few species found in Benarca Forest that were not recorded in most of these studies. Little Corella *Cacatua sanguinea* (recorded in 16% of diurnal surveys in Benarca Forest; present all seasons), Blue-faced Honeyeater *Entomyzon cyanotis* (5% of surveys; spring–autumn) and Red Wattlebird *Anthochaera carunculata* (59% of surveys; all seasons but most common autumn–winter) were not recorded at all

by Mac Nally *et al.* (2001), Antos and Bennett (2005), Webster and Rogers (2006) or Selwood *et al.* (2015) in the Barmah–Millewa and Gunbower–Koondrook–Perricoota Forests. All three species have been described as uncommon in the wider local area between Corowa and Swan Hill (Forestry Commission of NSW 1985). Little Corella is a relative newcomer to the Echuca–Moama area, reported by Hobbs (1961) as not found east of Euston (250 km north-west). Loyn *et al.* (2002) suggested that Blue-faced Honeyeater may have declined in Barmah Forest and described Red Wattlebird as a vagrant or rare visitor.

Landscape context

Very large woodland remnants like Barmah–Millewa Forest and Gunbower–Koondrook–Perricoota Forest are critically important for the conservation of woodland birds in agricultural landscapes. However, it is important also to recognise the complementary value of small remnants (Fischer and Lindenmayer 2002). The present paper highlights the contribution of the 206 ha Benarca Forest to supporting local populations of woodland birds and waterbirds. Benarca Forest also has connectivity value as a node in a 70 km long riverine forest corridor that provides a valuable link between these two larger woodland areas. The connectivity function of native riparian woodlands makes them critical landscape components in agricultural areas (Fisher and Goldney 1997; Bennett *et al.* 2014), and the present paper is one of the first published studies to examine the avian values of a part of this important wildlife corridor.

Management considerations

Benarca Forest is a popular location for recreational camping, with about 7000 person-nights per year. Impacts associated with recreational activities have included damage to ground and understorey vegetation by uncontrolled vehicle movement, and loss of large woody debris and standing dead trees used for campfire wood. Mac Nally and Horrocks (2007) highlighted the value of woody debris for birds, and the present study has documented the use of understorey vegetation and woody debris by several species of conservation concern. The recent introduction of dedicated camping areas in Benarca Forest should assist in managing recreational

impacts. Changes to natural flooding regimes as a result of river regulation and water resource development may also be having an adverse effect on waterbirds and woodland birds and their habitats in Benarca Forest (Leslie 2001; Fitzsimons *et al.* 2011; Reid *et al.* 2013; McGinness *et al.* 2015). Mitigation of this threat relies on management actions at the catchment scale.

Conclusion

Benarca Forest supports at least 18 bird species of conservation concern, and as part of a chain of riverine woodland remnants forming a significant regional wildlife corridor along the Murray River, is also valuable from a landscape connectivity perspective. Management of this small area of park requires finding a balance between sustainable recreational opportunities and protection of conservation values.

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Contents of Eastern Barn Owl *Tyto deliciatula* regurgitation pellets at the Werribee Sewage Farm, Victoria, suggest possible decline in abundance of Fat-tailed Dunnart *Sminthopsis crassicaudata*

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Abstract

The contents of 502 Eastern Barn Owl *Tyto deliciatula* regurgitation pellets collected at the Werribee Sewage Farm, Victoria, between 2008 and 2021 were analysed to investigate the local diet of this species. Results are compared with those of two similar studies at the same site in the 1970s and 1980s. House Mouse *Mus musculus* continues to dominate the diet of Barn Owls at the Werribee Sewage Farm, comprising 90.0% of identified prey items recovered and occurring in 63.9% of regurgitation pellets in this study. It was anticipated that Fat-tailed Dunnart *Sminthopsis crassicaudata* might form an increasing proportion of the owls' diet over time, since dunnart populations were expected to recover from south-eastern Australia's 'Millennium Drought' and also respond positively to a reduction in grazing pressure on grasslands at this property from 2010. However, in contrast to the findings of previous similar studies at this site, no Fat-tailed Dunnart remains were recovered from owl regurgitation pellets. (*The Victorian Naturalist* 138(6), 2021, 171–175)

Keywords: owl, dunnart, diet

Introduction

Analysis of owl regurgitation pellets is a recognised method of investigating the diet of owls (e.g. Debus *et al.* 2004, 2008; Fitzsimons *et al.* 2008) and, indirectly, as a supplementary technique for investigating the occurrence of small mammal fauna (e.g. Morton 1975; Smith and Cole 1989; Johnson and Rose 1994; McDowell and Medlin 2009b; Woolley 2009). Although there are known limitations to using pellet analysis to infer small mammal communities, or changes within these communities, it must be assumed that the owls are taking prey in direct relationship to their relative abundance at a site; that pellet collection provides a true representative sample of all owl pellets produced; and that pellet contents show a bias towards larger prey (e.g. Yom-Tov and Wool 1997; McDowell and Medlin 2009a, b).

The Western Treatment Plant—or Werribee Sewage Farm (WSF)—is a large, 11 550 ha sewage treatment facility located near the town of Werribee, Victoria. The facility is operated by Melbourne Water, a state government authority, and treats over half of the wastewater of Melbourne (Melbourne Water 2006). The property was acquired in stages from 1892 by the predecessor of Melbourne Water, the Melbourne and Metropolitan Board of Works

(MMBW). The original sewage treatment process involved application of raw sewage to pastures, and large numbers of stock (both sheep and cattle) were run by the MMBW to manage grass growth in irrigation paddocks (Penrose 2001; Melbourne Water 2006). These animals were required to be kept on 'clean' pastures, untainted by sewage, for a period before they could be moved off-site. As a result the WSF includes some 770 ha of unirrigated grassland (Melbourne Water 2008).

During the early 1970s, these grasslands supported a large population of Fat-tailed Dunnart *Sminthopsis crassicaudata* (Morton 1976, 1978a, 1978b, 1978c), a species categorised as Near Threatened in Victoria (Department of Sustainability and Environment 2013) although only Least Concern by the International Union for the Conservation of Nature (Burbidge *et al.* 2016). However, in recent decades the abundance of Fat-tailed Dunnart on these grasslands has apparently declined markedly (Schulz 1987; Peake and Carr 1994; Cropper 2002; Organ 2003, 2006; Schmidt 2012; E Scilicula pers. comm.). The unirrigated grasslands, or dry pasture, were heavily grazed and rated as poor to moderate quality remnant native grasslands in 2002 (Cropper 2002). Grazing

can adversely affect dunnart habitat quality (e.g. Hadden 2002) and this grazing, together with the Millennium Drought of 1996 to 2010, was thought to have caused a decrease in the Fat-tailed Dunnart populations on the WSF's unirrigated grasslands.

During the early 1970s, Morton conducted a major study of the Fat-tailed Dunnart population at the WSF. This included analysis of Eastern Barn Owl *Tyto deliciatula* regurgitation pellets (Morton 1975). Baker-Gabb conducted a similar owl pellet analysis at the WSF in the early 1980s (Baker-Gabb 1984). From 2010, land use practices changed across the WSF as land-based treatment of sewage was discontinued and former irrigation paddocks were converted to conventional irrigated pastures or crop-fields. Without the need for large numbers of grazing stock, the dry pasture country was earmarked for conservation (Melbourne Water 2006, 2008). This change saw a marked reduction in grazing pressure on the dry pastures and, land managers hoped, would see a rebound in the populations of native species of grassland animals, including the dunnart. Therefore, the opportunity was taken to repeat the work of Morton and Baker-Gabb and use owl pellet analysis to assess the expected increases in dunnart numbers as reflected in owl diet.

Methods

We set out to replicate the methods of Morton's 1975 study at the WSF. Morton (1975: 31) describes his method of finding owl pellets as:

Barn Owls roost in plantations of cypress trees on the Farm, and I found the roosts by walking along rows of pines and searching for pellets scattered on the ground

This basic search technique was followed in our study. Between September 2008 and March 2021, regurgitation pellets of Eastern Barn Owls were actively searched for along tree-lines, especially those near the unirrigated grassland areas of the WSF. Reports of sightings of owls were followed up and the ground beneath likely roost trees searched for signs of use (e.g. faeces, feathers or regurgitated pellets). Once a roost-tree was identified, the site was re-examined whenever possible and further searches for regurgitated pellets were carried out in the vicinity. Searches were carried out

opportunistically and no attempt was made to focus on any particular season.

After collection, the length and diameter of pellets were measured to the nearest millimetre using Vernier callipers. Pellets were broken up into very small pieces and all bones were recovered for identification to determine the number of mammals eaten. Hairs were identified using the methods of Brunner *et al.* (2002). Particular care was taken in searching for evidence of Fat-tailed Dunnart in the pellets, such as presence of the species' distinctive hair and jaw bones. Pellets were attributed to Eastern Barn Owl on the basis of their size and appearance (the mucosal coating of regurgitation pellets is characteristic of Tytonidae species; see Marshall 1986) but also on their contents. For example, some pellets contained no animal bones at all but only insect remains or mammal hair (likely scavenged European Rabbit *Oryctolagus cuniculus*). Such pellets were excluded from this study as likely to be from Brown Falcon *Falco berigora*, Whistling Kite *Haliastur sphenurus*, or similar species.

Results

A total of 502 Eastern Barn Owl regurgitation pellets were collected from nine sites across the WSF between late 2008 and March 2021 (Tables 1–3). Mean pellet length was 35.6 ± 7.73 mm ($n=331$; range 17–75 mm) and pellet diameter 22.9 ± 4.19 mm ($n=331$; range 14–38 mm).

Most pellets (>90%) were collected between 2008 and 2015, inclusive (Table 2). This covers both the period of below average annual rainfall during the late Millennium Drought and high rainfall years of 2010 to 2012. Almost half of the owl pellets (47.0%) were collected during spring (September–November), and a further 39.6% during winter (June–August) (Table 3). Pellets produced during spring might be expected to contain dunnart remains should this species be a prey item for the owls.

Contents of the owl pellets were dominated by House Mouse *Mus musculus* remains, both by proportion of identified prey items (594 of 660 prey items, or 90.0%) and frequency of occurrence in regurgitation pellets (321 of 502 pellets, or 63.9%). No Fat-tailed Dunnart remains were found in any of the pellets

Table 1. Summary of locations where Eastern Barn Owl regurgitation pellets were collected at the Werribee Sewage Farm, Werribee, Victoria.

Site	Description	Location	No. pellets collected
A	Cocoroc historic township (old water tower and shed)	37° 57' 02" S, 144° 38' 02" E	85
B	Isolated sheoak at Lake Borrie Spit grassland	38° 00' 31" S, 144° 33' 55" E	110
C	Large cypress alongside Main Western Carrier at siphon on River Road	37° 59' 08" S, 144° 33' 41" E	4
D	Cypress tree alongside Main Western Carrier near silos on Murtaim Road	37° 58' 15" S, 144° 34' 34" E	51
E	Cypresses at Ryans Swamp inlet channel	37° 58' 31" S, 144° 33' 23" E	51
F	Moonah shelter belt	37° 59' 00" S, 144° 35' 42" E	138
G	Eucalypt plantation alongside New Farm Road	37° 58' 26" S, 144° 37' 44" E	42
H	Tree-line alongside 160 South Road at Jetty Reserve	37° 58' 50" S, 144° 40' 40" E	20
I	Lollypop Creek	37° 56' 32" S, 144° 36' 54" E	1

Table 2. Eastern Barn Owl regurgitation pellets collected each year at the Werribee Sewage Farm.

Year	No. pellets	Percentage
2008	48	9.6
2009	110	21.9
2010	68	13.6
2011	22	4.4
2012	56	11.2
2013	85	16.9
2014	0	—
2015	69	13.8
2016	17	3.4
2017	0	—
2018	22	4.4
2019	1	0.2
2020	0	—
2021	4	0.8
Total	502	100.0

analysed (Table 4). Insect pupal cases and seeds or other plant debris were found in a small proportion of pellets (Table 4), but these are assumed to be post-deposition introductions rather than prey items.

Discussion

Both Morton (1975) and Baker-Gabb (1984) recorded Fat-tailed Dunnart remains in owl pellets from the WSF and there is no reason to suggest pellet analysis was an inappropriate

Table 3. Eastern Barn Owl regurgitation pellets collected per month at the Werribee Sewage Farm.

Month	No. pellets	Percentage
January	8	1.6
February	0	—
March	46	9.2
April	0	—
May	0	—
June	112	22.3
July	70	13.9
August	17	3.4
September	60	11.9
October	158	31.5
November	18	3.6
December	13	2.6
Total	502	100.0

method for detecting dunnart remains, or for determining the relative abundance of this species in the recent diet of owls at the property, and how this might change over time.

Results of this study contrast markedly with the results of similar studies at the WSF from earlier decades (Morton 1975; Baker-Gabb 1984; Higgins 1999). No dunnart remains were recovered from 502 owl pellets collected from the site between 2008 and 2021. In contrast, both Morton (1975) and Baker-Gabb (1984) found a small proportion of owl pellets

Table 4. Contents of 502 Eastern Barn Owl regurgitation pellets collected at the Werribee Sewage Farm, Werribee, Victoria.

Taxa	No. of pellets	Per cent occurrence	No. items	Per cent abundance
<i>Mus musculus</i>	321	63.9	594	90.0
<i>Rattus rattus</i>	18	3.6	18	2.7
<i>Rattus norvegicus</i>	2	0.4	2	0.3
Microbat	1	0.2	1	0.2
<i>Oryctolagus cuniculus</i>	4	0.8	4	0.6
Feathers	29	5.8	29	4.4
Reptile scales	9	1.8	9	1.4
Crustacea	5	1.0	5	0.8
Coleopterans	2	0.4	2	0.3
Insect pupae	33	6.6	—	—
Grass seeds	3	0.6	—	—
Other plant material	10	2.0	—	—

collected during their studies contained Fat-tailed Dunnart remains (<2% of prey items).

It was anticipated dunnart numbers at WSF would rebound following the breaking of the intense and extended drought of 1996 to 2010. It was further anticipated that a return to 'normal' rainfall, combined with a significant reduction in the grazing pressure applied to the unirrigated grasslands, would lead to improvement in the condition of these grasslands and consequently a likely increase in abundance and/or distribution of dunnarts across the site, which would be reflected in owl pellet contents. The absence of dunnart remains in recent owl pellets does not, by itself, confirm any reduction in dunnart numbers at the property since the absence may be for other reasons, such as an increase in numbers or availability of House Mouse. However, our finding—that the contribution Fat-tailed Dunnart makes to the diet of owls at the WSF is less now than in the 1970s—supports results from grassland mammal surveys at the property. These mammal surveys, although far from comprehensive, suggest a sharp decline in both the distribution and abundance of the species across the WSF grasslands, with no sign of recovery post-drought (Schulz 1987; Peake and Carr 1994; Cropper 2002; Organ 2003, 2006; Schmidt 2012; E Scicluna pers. comm.).

Hadden (2002) found that Fat-tailed Dunnart was more common on lightly grazed grasslands than on heavily grazed ones and suggested that heavy grazing adversely affected dunnart populations through a reduction in the

availability and quality of groundcover. Our results fail to show, indirectly, any increase in dunnart numbers in response to a significant reduction in grazing pressure on unirrigated grasslands at the WSF. We believe this to be, in part, because grazing was reduced too far. Following the reduction in grazing and breaking of the drought—both occurring around 2010—the unirrigated grasslands generally developed a dense thatch of cover. This was not suitable habitat for Fat-tailed Dunnart, which prefers open grassland with patches of bare ground (e.g. Menkhorst 1995; Menkhorst and Knight 2011). While it was recognised that the grazing of the WSF grasslands was not achieving the outcomes intended after some years of the new grazing plan, it proved difficult to conduct burning to reduce the thatch, or to deliver the appropriate grazing pressure when needed. The need to consider an infestation of Chilean Needle-grass *Nassella neesiana* was a further complication influencing grassland management.

There are many factors other than grazing potentially acting to depress dunnart populations at the WSF, e.g. introduced predators, toxoplasmosis, habitat fragmentation, removal of surface rock, changes in rainfall, and pesticide use. Our intent to improve grassland values through reduced grazing pressure alone was unsuccessful in evoking a response in a small native mammal population. This case illustrates some of the difficulties of wildlife management, where success is often dependent on multiple factors, not all of which are amenable to management. Efforts are continuing to improve the

grasslands, and their associated faunal populations, through burning, managed grazing and targeted weed control.

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A relict population of *Pseudophryne* toadlets in the Ocean Grove Nature Reserve, southern Victoria

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Abstract

Six individual *Pseudophryne* toadlets were heard calling in the Ocean Grove Nature Reserve, south of Geelong in Victoria, in autumn 2020. Three individuals had patterns intermediate between *P. bibronii* and *P. semimarmorata*, and it is concluded that this population is an intergrade. Another five were detected in autumn 2021. This population is potentially at risk from a reduction in autumn rainfall and consequent changes to the local hydrology. Additional surveys for calling *Pseudophryne* at historical locations and other suitable habitat within 40 km of Ocean Grove failed to find any calling individuals. (*The Victorian Naturalist* 138(6), 2021, 176–180)

Keywords: Bibron's Toadlet, *Pseudophryne bibronii*, Southern Toadlet, *Pseudophryne semimarmorata*, Ocean Grove Nature Reserve

Records of *Pseudophryne* toadlets at Ocean Grove Nature Reserve

The 143 ha Ocean Grove Nature Reserve (OGNR) is the largest relict of natural vegetation, other than coastal and wetland vegetation, on the Bellarine Peninsula south-east of Geelong, Victoria (Fig. 1). It has been the focus of attention by local naturalists, particularly under the auspices of the Geelong Field Naturalists Club, since it was purchased by community-led public appeals held in 1969 and 1973. A specimen of a *Pseudophryne* toadlet taken in 2000 (King 2000) is the only historical record of this genus in OGNR.

In autumn 2018, *Pseudophryne* calls were heard and recorded in OGNR by A Byrne. Following this record, the Geelong Field Naturalists Club placed roofing tiles in nearby locations to survey for *Pseudophryne* in the OGNR. None was found under the tiles through to autumn 2021, despite some tiles being placed within a few metres of locations of calling *Pseudophryne*.

Pseudophryne spp. are best surveyed when they call after heavy autumn rains. In autumn 2019, there was <30 mm of precipitation in March and April, and no surveys were undertaken. In autumn 2020, after >30 mm precipitation on 3 April, six *Pseudophryne* were heard calling in OGNR. These were all around ephemerally inundated depressions along about 100 m of a drainage line that has

subsurface flows most winters. Smaller numbers were heard on most damp nights until the last call was heard on 16 May, after which the conditions (an extended dry period followed by colder winter temperatures) were unsuitable for calling. Three individuals were seen and photographed for identification. No additional calling individuals were located in comprehensive surveys across OGNR. These involved listening for at least two minutes within 10 m of any location that might be inundated following heavy precipitation, and occasionally playing recorded calls. There is considered to be a greater than 90% chance of detecting any calling *Pseudophryne* within two minutes of listening (Howard *et al.* 2010).

The autumn of 2021 was again relatively dry, with a total of 143 mm of rain from March to May. The only daily rainfall total above 11 mm was 33 mm on 4 May. During surveys in OGNR the next day (5 May 2021), five individuals were heard at the same locations as in 2018 and 2020.

Taxonomic status of *Pseudophryne* toadlets at OGNR

The *Pseudophryne* specimen from OGNR in 2000 was identified as Bibron's (or Brown) Toadlet *P. bibronii* due to its blue-tinged white under parts marbled with black; however, it was extracted from a preserving fluid which might have stripped it of colour (King 2000).

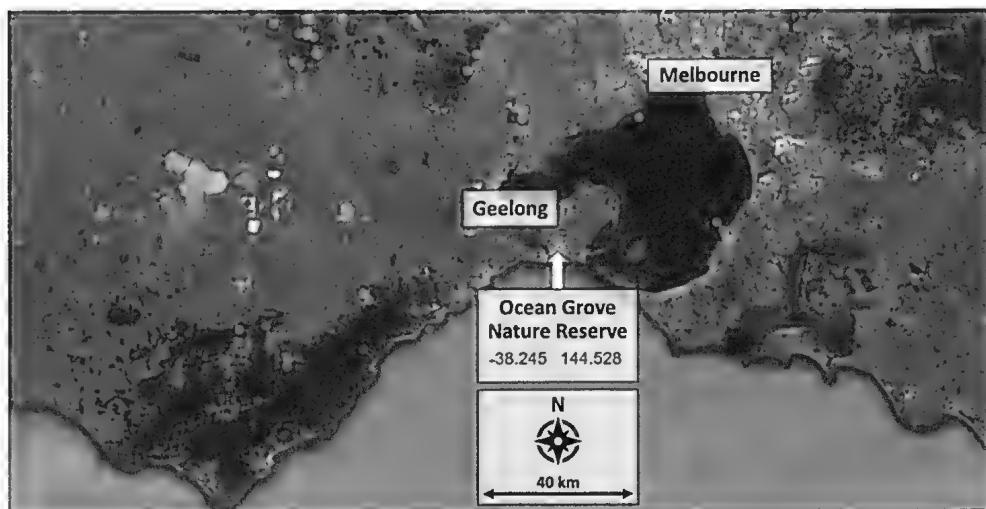


Fig. 1a. Records of *P. bibronii* (yellow) and *P. semimarmorata* (red) and both species (orange) from 1856–2021 (from *The Atlas of Living Australia* 2021). (Note that some records are unsubstantiated, e.g. the record of *P. bibronii* from suburban Geelong is accompanied by a photograph of an Eastern Banjo Frog *Limnodynastes dumerilii*).



Fig. 1b. As for Fig. 1a, using data from 2000–2021.

All three specimens photographed at OGNR in 2020 had some yellow on their under parts, but with significant variation between them (Fig. 2). The upper parts of the dullest individual had no yellow. The upper parts of the yellowest individual had a little yellow extending around the upper legs and a faint yellow sagittal line extending from the anus (Fig. 3).

Pseudophryne bibronii has orange or yellow restricted to the base of each limb, around the anus and a faint cocygeal stripe, whereas the lower surfaces of the Southern Toadlet *P. semimarmorata*'s limbs are uniformly flesh-coloured to orange (Cogger 2014). Their calls are identical. The two species intergrade where their ranges abut (Littlejohn 1963; Woodruff



Fig. 2. Under parts of three individual *Pseudophryne* sp. at Ocean Grove Nature Reserve.



Fig. 3. Upper parts of the yellowest individual *Pseudophryne* sp. at Ocean Grove National Reserve.

and Tyler 1968). The pattern of the OGNR individuals is intermediate between *P. bibronii* and *P. semimarmorata*. Given the geographical distribution of these species (Fig. 1), it is concluded that the OGNR individuals are intergrades. This extreme southern occurrence of *P. bibronii* intergrades is consistent with OGNR and the wider Geelong region being in a rain-shadow from the prevailing westerly winds, with a recent mean annual precipitation of 610 mm at Ocean Grove. This population at OGNR appears to be a last relict from the original distribution of *P. bibronii* and intergrades across this largely cleared drier region.

Distribution of *Pseudophryne* toadlets south-west of Melbourne

South-west of Melbourne, *P. bibronii* is known historically (Fig. 1a: *The Atlas of Living Australia*, accessed 8 August 2021) from numerous sites south of Ballarat (with outliers at Cressy), the Brisbane Ranges (five field records in 1989), the You Yangs (three specimens from 1962 to 1977 and three field records 1978–1989), and the following records south of Geelong:

- One specimen from OGNR (King 2000), as discussed above;
- One specimen from 2.4 km west of Jan Junction (*sic*, i.e. Jan Juc), near Torquay in 1966;

- One specimen from the Point Addis turnoff on Torquay–Anglesea Road in 1973;
- One specimen from Bambra Bushland Reserve (undated);
- One specimen from Gellibrand River, Yaughaner (but mapped at the West Barwon Dam) in 1967;
- One sighting from Colac–Lavers Hill Road at Barongarook in 2016.

Given the re-identification of the OGNR population, it is suggested that some of these records might refer to *P. semimarmorata* or intergrades.

Conservation status of *Pseudophryne* in Ocean Grove Nature Reserve and south-west of Melbourne

Pseudophryne bibronii is listed in Victoria's *Flora and Fauna Guarantee Act 1994* and is categorised as 'near threatened' in the global IUCN Red List (Hero *et al.* 2004) based on long-term declines in the number of populations. For example, surveys of 106 sites north-east of Melbourne after the 2009 fires found only two individual *P. bibronii* and two individual *Pseudophryne* species (Howard *et al.* 2010). However, members of the genus remain locally common at some sites (see Terry 2017).

The *Pseudophryne* population in OGNR is very small, with a maximum of six individuals heard calling. The OGNR population is potentially at risk from changes to the local hydrology caused by a reduction in autumn rainfall, as predicted by climate models and observed in recent years. Despite moderate rains in autumn 2020, none of the ephemerally inundated depressions where the *Pseudophryne* were calling filled with water, and it is assumed that breeding was unsuccessful. Active habitat management should be considered.

Additional surveys were undertaken in April and May 2020 for calling *Pseudophryne* at historical locations and, based on close examination of satellite maps and daytime visits, all other suitable habitat within 40 km of OGNR. Most of this area is cleared (survey sites are listed in the Appendix). A total of 27 sites were surveyed, mostly spot-locations but including 10 km of creek lines around Anglesea Heath. Surveys consisted of at least two minutes of listening on nights above 10° C between 9 April

and 4 May 2020, a period during which *Pseudophryne* were calling regularly in OGNR. No *Pseudophryne* was recorded away from OGNR, but many sites lacked inundated areas, even in depressions and creek beds, so repeat surveys in wetter autumns are warranted.

The small population size at OGNR and negative records from other 2020 surveys are concerning. In the last extensive regional surveys, in autumn 2011, *Pseudophryne* were detected at only two locations near Anglesea, with negative records from over 90 sites inland of Anglesea and Airey's Inlet, over 200 sites in the western Otways, and about 200 survey sites in the Brisbane Ranges and Enfield State Forest areas (G Peterson, unpubl. 2020). Further surveys are clearly warranted, especially if the persistence of *Pseudophryne* populations could influence management actions such as roadside drainage works.

Acknowledgements

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Appendix: Survey sites for *Pseudophryne* between 9 April and 4 May 2020.

Bellarine Peninsula

The Basin Reserve, Basin Road, Drysdale;
Drakes Reserve, Drakes Road, Drysdale;
Indented Head Woodland Reserve, Indented Head;
Grassy Point Road at Murradoc Road, St Leonards;
Anderson Road at Manifold Road, St Leonards;
Swan Bay Road and Knights Road near Banks Road, Mannerim;
Creek, south end of Maddens Lane;
Yarram Creek, Banks Road, Marcus Hill;
Swan Bay Road Reservoir, including inflow near Grubb Road and outflow to the east.

Torquay

Drainage line north of eastern Coombes Road (1966 site; now unsuitable habitat);
Frog Hollow Reserve, Torquay;
Bellbrae Nature Reserve, Bellbrae.

Anglesea Heath

Ironbark Basin dam (dry; closest water to 1973 record);
Creek at Hurst Road, Anglesea;
Dam off Great Ocean Road, Eumeralla;
Creek from dam (above) to Eumeralla camp;
Coogorah Park, Anglesea (unsuitable habitat);
Creeks along Alcoa Boundary Track to Allardyce Track (3 km);
Merrigig Creek at Brushfield Road/Loutit Bay Road;
Creeks south of Tanners Road/Forest Road (2.7 km);
Creek at Flaxborne's Road/Forest Road;
Creek north and south of Gum Flats Road (2.5 km; dry);
Distillery Creek, Airey's Inlet (1.6 km; dry).

West of Geelong

Inverleigh Nature Conservation Reserve (limited surveys at best habitat on 17 May);
Bannockburn Bush (daytime surveys on 17 May failed to find any suitable inundated habitat);
You Yangs (extensive surveys on publicly accessible land 21 May);
Anakie Gorge and Sapling Gully, Brisbane Ranges (limited surveys at best habitat on 21 May).

Changes to birdlife in and near Notting Hill, Victoria, 1976–2021

'Have you seen the parrots?' asked my next-door neighbour excitedly. 'We never used to see them here!' The year was 1976, and the parrots were Eastern Rosellas. Having recently moved into my home in the Melbourne suburb of Notting Hill, I was keen to observe all the species of birds that lived there, and started listing them immediately. My principal area of observation was bounded by Ferntree Gully Road to the north, Blackburn Road to the west, Duerdin Street to the south, and to the east a strip of land used for horse agistment but zoned for a proposed arterial road. Outside the Notting Hill boundary, I also investigated the area beside Ferntree Gully Road between Westerfield Drive and Springvale Road, particularly from May 1984 to May 1985, when I took part in a Bird Observers Club survey of birds seen in roadside plantations of Australian native vegetation.

Back in 1976 this suburb was relatively new, but old enough to have gardens sufficiently well established to attract birds. (The first houses were built in the late 1950s; ours about 1965.) Apart from the houses and gardens, there were some open grassy areas with Bramble *Rubus* sp. and Gorse *Ulex europaeus* bushes, providing habitat for Superb Fairy-wrens and Yellow-rumped Thornbills, and also serving as hunting grounds for several raptor species that could be seen from time to time. White-plumed Honeyeaters were numerous. During autumn and winter, Grey Fantails, Flame Robins and, occasionally, Scarlet Robins were welcome visitors, and Grey Shrike-thrushes that used to live in the nearby Jock Marshall Reserve sometimes ventured into people's gardens. Fantailed Cuckoos, Pallid Cuckoos and Shining Bronze-Cuckoos used to arrive in spring, while in summer there were occasional visits from Rufous Fantails and flocks of White-throated Needletails and Fork-tailed Swifts.

Over time, there have been changes in species composition. Many of the small birds have disappeared, and hardly any White-plumed Honeyeaters live here now. Some species have come and gone: White-browed Scrubwrens, for example, came in 2000 and stayed until

mid 2015, by which time so much vegetation had been cleared that this area was no longer suitable for them. Other species have come and stayed: I first saw Brown Thornbills here in the 1990s and they are still present. Dry-country birds such as Long-billed Corellas, Little Corellas and Crested Pigeons arrived about 2000; some Crested Pigeons are still present, but the Corellas come and go.

By 2021, through opportunistic observations, I had recorded 97 species of birds in this area. Five of these were aviary escapes that have not established breeding populations here (Table 1). The remaining 92 comprise 11 introduced species (Table 2) and 81 native Australian species (Table 3). Of the 11 introduced species, five are no longer present, and a sixth has become very rare. As far as I can tell, 43 of the 81 native species are no longer present, which means that more than half the bird species that once occurred in or visited this area have gone — a huge loss.

Not only are there fewer species of birds than there used to be, but with the exception

Table 1. Aviary escapes recorded at Notting Hill, Victoria, 1976–2021.

Species	Scientific name
Cockatiel	<i>Nymphicus hollandicus</i>
Peach-faced Lovebird	<i>Agapornis roseicollis</i>
Pale-headed Rosella	<i>Platycercus adscitus</i>
Budgerigar	<i>Melopsittacus undulatus</i>
Zebra Finch	<i>Taeniopygia guttata</i>

Table 2. Introduced birds recorded at Notting Hill, Victoria. Names in red indicate species not seen there by the author for two years or more. House Sparrow is now very rare, and possibly no longer present.

Species	Scientific name
Rock Dove	<i>Columba livia</i>
Spotted Dove	<i>Spilopelia chinensis</i>
Eurasian Skylark	<i>Alauda arvensis</i>
Common Blackbird	<i>Turdus merula</i>
Song Thrush	<i>Turdus philomelos</i>
Common Starling	<i>Sturnus vulgaris</i>
Common Myna	<i>Acanthotheres tristis</i>
House Sparrow	<i>Passer domesticus</i>
Eurasian Tree Sparrow	<i>Passer montanus</i>
European Goldfinch	<i>Carduelis carduelis</i>
Common Greenfinch	<i>Chloris chloris</i>

Table 3. Australian native birds recorded by the author at Notting Hill, Victoria. The order used follows Christidis and Boles (2008). The names are those used by Menkhorst *et al.* (2017). Names in red indicate species not seen there by the author for two years or more. Names in blue indicate species absent from Notting Hill but sometimes present in nearby habitats. * = single dead specimen only.

Species	Scientific name
Stubble Quail *	<i>Coturnix pectoralis</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Crested Pigeon	<i>Ocyphaps lophotes</i>
Tawny Frogmouth	<i>Podargus strigoides</i>
White-throated Needletail	<i>Hirundapus caudacutus</i>
Fork-tailed Swift	<i>Apus pacificus</i>
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
White-necked Heron	<i>Ardea pacifica</i>
Great Egret	<i>Ardea alba</i>
Eastern Cattle Egret	<i>Bubulcus coromandus</i>
White-faced Heron	<i>Egretta novaehollandiae</i>
Australian White Ibis	<i>Threskiornis molucca</i>
Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Black-shouldered Kite	<i>Elanus axillaris</i>
Brown Goshawk	<i>Accipiter fasciatus</i>
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>
Nankeen Kestrel	<i>Falco cenchroides</i>
Brown Falcon	<i>Falco berigora</i>
Australian Hobby	<i>Falco longipennis</i>
Peregrine Falcon	<i>Falco peregrinus</i>
Buff-banded Rail	<i>Gallirallus philippensis</i>
Masked Lapwing	<i>Vanellus miles</i>
Painted Button-quail *	<i>Turnix varius</i>
Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>
Galah	<i>Eolophus roseicapilla</i>
Long-billed Corella	<i>Cacatua tenuirostris</i>
Little Corella	<i>Cacatua sanguinea</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Musk Lorikeet	<i>Glossopsitta concinna</i>
Little Lorikeet	<i>Glossopsitta pusilla</i>
Crimson Rosella	<i>Platycercus elegans</i>
Eastern Rosella	<i>Platycercus eximius</i>
Swift Parrot	<i>Lathamus discolor</i>
Red-rumped Parrot	<i>Psephotus haematonotus</i>
Shining Bronze-Cuckoo	<i>Chalcites lucidus</i>
Pallid Cuckoo	<i>Cacomantis pallidus</i>
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>
Eastern Barn Owl *	<i>Tyto deliciatula</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Sacred Kingfisher	<i>Todiramphus sanctus</i>
Superb Fairy-wren	<i>Malurus cyaneus</i>
White-browed Scrubwren	<i>Sericornis frontalis</i>
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>
Brown Thornbill	<i>Acanthiza pusilla</i>
Spotted Pardalote	<i>Pardalotus punctatus</i>
Striated Pardalote	<i>Pardalotus striatus</i>
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>
White-plumed Honeyeater	<i>Ptilotula penicillata</i>
Noisy Miner	<i>Manorina melanocephala</i>
Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>
Little Wattlebird	<i>Anthochaera chrysoptera</i>
Red Wattlebird	<i>Anthochaera carunculata</i>
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>
White-naped Honeyeater	<i>Melithreptus lunatus</i>
Black-faced Cuckoo-Shrike	<i>Coracina novaehollandiae</i>

Table 3. cont.

Crested Shrike-tit	<i>Falcunculus frontatus</i>
Golden Whistler	<i>Pachycephala pectoralis</i>
Rufous Whistler	<i>Pachycephala rufiventris</i>
Grey Shrike-thrush	<i>Colluricinclla harmonica</i>
Grey Butcherbird	<i>Cracticus torquatus</i>
Australian Magpie	<i>Cracticus tibicen</i>
Pied Currawong	<i>Strepera graculina</i>
Grey Currawong	<i>Strepera versicolor</i>
Rufous Fantail	<i>Rhipidura rufifrons</i>
Grey Fantail	<i>Rhipidura albiscapa</i>
Willie Wagtail	<i>Rhipidura leucophrys</i>
Little Raven	<i>Corvus mellori</i>
Satin Flycatcher	<i>Myiagra cyanoleuca</i>
Magpie-lark	<i>Grallina cyanoleuca</i>
Scarlet Robin	<i>Petroica boodang</i>
Flame Robin	<i>Petroica phoenicea</i>
Golden-headed Cisticola	<i>Cisticola exilis</i>
Rufous Songlark	<i>Megalurus mathewsi</i>
Silvereye	<i>Zosterops lateralis</i>
Welcome Swallow	<i>Hirundo neoxena</i>
Fairy Martin	<i>Petrochelidon ariel</i>
Tree Martin	<i>Petrochelidon nigricans</i>
Australian Pipit	<i>Anthus australis</i>

of Noisy Miners (Fig. 1) and Rainbow Lorikeets (see front cover), there are also far fewer individuals—a trend that has become particularly noticeable since 2009. One reason for this decline is obvious enough: habitat loss and modification. Houses have been and continue to be demolished and each block of land filled

with as many new residences as practicable. Gardens are ripped out to make room for extra housing, and some of the formerly grassy land has been covered with large buildings and concrete pavement. In March 2017, the State Government introduced a mandatory requirement for a garden area in all residential developments in the Neighbourhood Residential and General Residential Zones, including single dwellings and subdivisions. However, the definition of ‘garden area’, although implying the use of plants, includes swimming pools, tennis courts, water tanks, pathways and outdoor entertaining areas (Victoria. Department of Environment, Land, Water and Planning 2018). Furthermore, the use of pebbles, gravel, and in some cases artificial turf, which are of little use to invertebrates or their avian predators, can help create a sterile landscape favoured by many busy humans because little maintenance is required.

Eucalypts have been planted in some of the remaining open space (e.g. Fig. 2), creating a pleasant area for humans and attracting Musk Lorikeets, Rainbow Lorikeets and Noisy Miners. According to the leaflet *Bird Life at Monash* (1978), Aston and Balmford (1978), and my own observations, Rainbow Lorikeets and Noisy Miners used not to be numerous here. When overabundant, as they are now, both species can be pests (Chapman 2005;



Fig. 1. Noisy Miner *Manorina melanocephala*.



Fig. 2. Grassy area planted with eucalypts at Notting Hill, Victoria; habitat favoured by Noisy Miners and Rainbow Lorikeets, and enjoyed by humans.

Threatened Species Scientific Committee on Amendments to the List of Key Threatening Processes 2014), and the Noisy Miner is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*. Noisy Miners are very aggressive, driving out smaller birds and taking over any habitat that suits them. In some places Red and Little Wattlebirds are keeping them at bay, but it will probably be only be a matter of time before the Miners succeed.

Today, it is still sometimes possible to see one or two Eastern Rosellas here, but if my neighbours asked if I'd seen 'the parrots', they would almost certainly be referring to flocks of Rainbow Lorikeets.

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At Home in the Land: The Plenty-Yarra Corridor

by Geoff Lacey

Publisher: *The Author, Clifton Hill, Victoria, 2021. 112 pages, paperback. Maps, images.*
ISBN 9780646835044. RRP \$24.

Geoff Lacey is the author of at least six books (the current one included) and numerous published papers and seminar presentations. This book was released earlier in 2021 and has the usual high quality photos by the author and very clear diagrams by John Waddingham. Lacey is a patient and acute observer of the land and what is in it. The information in the book is accurate and presented in an organised way.

Its intended audience is anyone who is curious or wishes to learn more about the peri-urban river and creek corridors of the Plenty and adjacent Yarra Rivers and their landscapes, plants and animals. It builds on two of Lacey's previous books (*Still glides the stream* 2004 and *Reading the Land* 2008). Although relatively short, *At Home in the Land* provides fascinating information about the early history of the Plenty River, especially for those who are not familiar with the Plenty-Yarra River corridor and its habitats.

The author freely quotes other writers to help make a point or assist in explaining an issue or theme. Throughout the text there are pointers to the way we should be treating and caring for the land around us. His succinct use of words, without technical terms, easily conveys to why these riparian habitats are important and why we need to sympathetically manage and preserve them.

The preface clearly explains the author's intent and what will be discussed. This includes his premise that ...

if we are to live sustainably on the Earth then we need to know it intimately—in its landscapes, and ecosystems, in its web of connections, and its history (p. v).

As a naturalist, Lacey recognises the importance of amateur observers in documenting the natural world. The last sentence on

page 7 could be used in reference to the Field Naturalists Club:

The naturalists convey a great detail about the natural world and its value, through simply looking and recording — or through drawing and painting.

I was especially pleased to read that being in nature requires more than just observing. Nature has its own impact: '... landscape is full of power and meaning, if we care to encounter it.'

The major part of the book is in sections 3 and 4 (pp. 19–85), which cover the Plenty River corridor and Yarra River between the Plenty and Merri Creek. This is where the reader learns about the ecological and related human history of this region, including past and recent impacts of fires, land clearing and the experience of previous observers and settlers in this part of Victoria.

Part 5 of the book then looks at how ecological corridors interact with the urban environment, in this case Melbourne city, and how this interaction serves to nourish us all. The final section of the book (Part 6) provides the author's views and understanding of how ecology, justice and wisdom are all connected.

Concise and clear maps with a suite of the author's own photographs illustrate various habitats. Some of these made me keen to visit certain sites myself.

At home in the land also provides the opportunity to learn about the early history of the Plenty River while also noting that humans, by observing and caring for nature, can be directly involved in its future.

In accordance with the author's aims, I found the book increased my knowledge and appreciation of the Plenty River environs and habitats. The final sentence neatly summarises the intent

of the book and why this may be important to all of us:

'... in the valley of the Yarra...and the other tributaries, many of us have begun to see the world differently, to be at home in the land, to rediscover our local place ...' (p. 99).

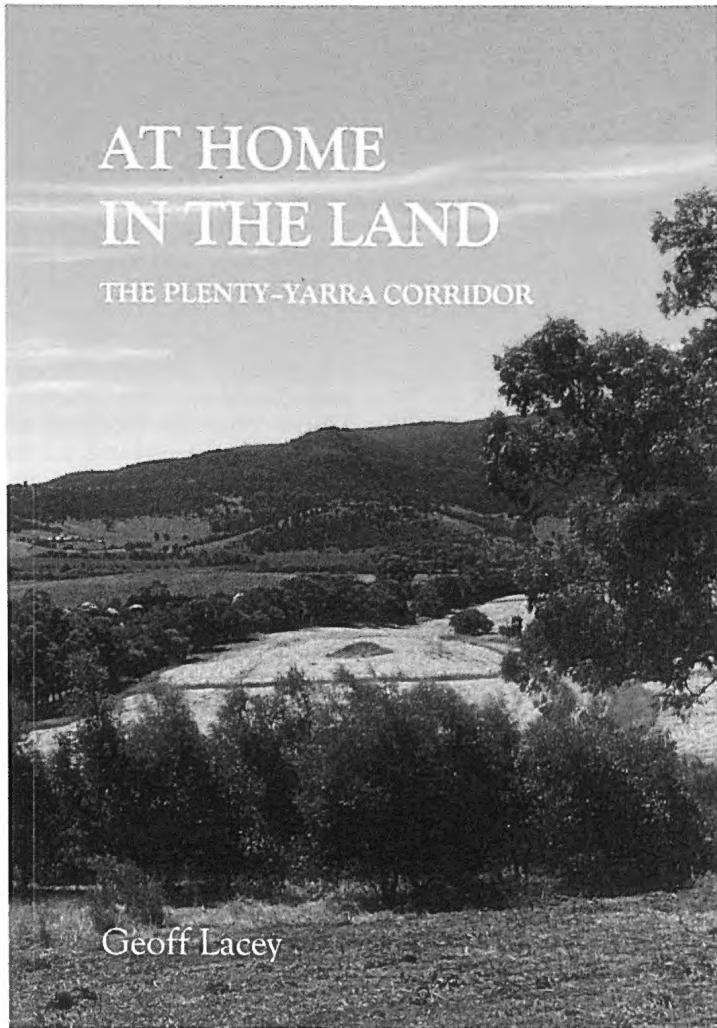
Lacey has created a good, informative read, employing an easy-to-understand style and succinct use of words to explain the complexity of a natural to semi-natural environment near Melbourne. I can recommend the book to anybody interested in habitats within the greater Melbourne area.

The book is on sale at Readings Carlton, and is also available from the author: Email <glacey@unimelb.edu.au>.

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Thank you from the editors

The Victorian Naturalist could not be published, and would not be successful without the enormous amount of time and effort given voluntarily by a large number of people who work behind the scenes.

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